International Journal of Mechanical and Production
Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 6, Issue 1, Feb 2016, 33-40

INVESTIGATION OF DOUBLE CIRCUMFERENTIAL U AND V SHAPE NOTCH BAR FOR STRESS CONCENTRATION USING FEA

S. S. BAVISKAR[1] & P. G. PATIL[2]

[1]*Research Scholar, S. G. D. College of Engineering, Jalgaon, Maharashtra, India*

[2]*Associate Professor, S. G. D. College of Engineering, Jalgaon, Maharashtra, India*

ABSTRACT

Many engineering components contain key way, shoulders and grooves, also in terms of notches. When notch shaft loaded in tensile loading at this stages stress concentration is produced at the notch root area. In this studied use U and V shape double circumferential notch shaft. In this paper studied the stress and strain concentration in U and V shape double circumferential notch shaft by FEA investigation at axial loading. In this paper analysis of result comparison between U and V shape of notch bar at same loading condition.

KEYWORDS: Axial Load, FEA, Stress-Strain Concentration, Notch

Received: Jan 06, 2016; **Accepted:** Jan 13, 2016; **Published:** Jan 22, 2016; **Paper Id.:** IJMPERDFEB20164

Original Article

INTRODUCTION

In various engineering shaft use different grooves and notches like U shape, V shape, Plain shape. But in this studied use double circumferential notch shaft and use shape of notch is U shape and V shape. When the notch component is loaded axially, maximum stress and strain concentration occurs at notch root area. So, maximum and total deformation of notch shaft is maximum at notch root area. In this paper studied the stress-strain concentration effect on U and V shape notch bar at various axial loads. This result compare by FEA investigation.

PROBLEM DEFINITION

The problem under consideration is to investigate the interference effect of U shape notch and V shape notch shaft at various axial loading conditions by FEA analysis.

The detail work is carried out with the help of FEA analysis software ANSIS 12.

FEA INVESTIGATION

A typical ANSYS analysis has three distinct steps:

- Build the model.
- Apply loads and obtain the solution.
- Review the results.

These steps are performed using pre-processing, solution and post-processing processors of the ANSYS program.

Actually, the first step in an analysis is to determine which outputs are required as the result of the

analysis, since the number of the necessary inputs, analysis type and result viewing methods vary according to the required outputs.

After determining the objectives of the analysis, the model is created in pre-processor. The next step, which is to apply loads, can be both performed in pre-processor or the solution processor. However, if multiple loading conditions are necessary for the required outputs and if it is also necessary to review the results of these different loading conditions together, solution processor must be selected for applying loads. The last step is to review the results of the analysis using post-processor, with numerical queries, graphs or contour plots according to the required outputs.

- **Specimen Geometries**

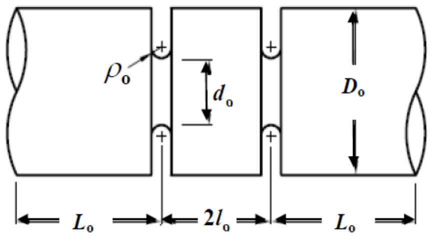

Figure 1: Specimen Geometry

The employed cylindrical bar with double circumferential U-notches is shown in Figure 1 The net-section diameter is denoted by d_o (in mm), the gross diameter is denoted by D_o (in mm), D_o=50mm, $2L_o$= the un-notched length from the notch center to the loaded end, $2l_o$= the notch pitch or the distance between the centers of the two notches. The specimen length is expressed as, Specimen length=$2L_o+2l_o$.The un-notched length is held constant, while the half notch pitch l_o is varied from 0.0 to 25 mm to examine the interference effect of the double circumferential U-notches. It should be noted that the notch angle $\gamma = 0^0$ represents the cylindrical bar with a circumferential U-notch, perpendicular to the axial direction.

- **B. FE Modeling**

The effect of notch parameters such as various loads on U shaped notches for axial loading is performed and investigation of stress distribution at notch surface is obtained by FEA (ANSYS 12).

The output of FEA are used deriving the characteristic curves & comparative statistics of various notch loads as an attempt to set the standard load and notch selection for specific application in future.

The effect on U shape notch at various loads such as 2500N, 5000N, 7500N, 10000N, 12500N and 15000N are observed for stress and strain distribution and check for stress concentration over the notch surface. The FE analysis for various loading condition are as follows:

- **Sample Results on U Shape Notch Bar**

Effect on U shaped notch at 2500N axial load.

For notch depth 6mm, notched diameter 38mm and un-notched diameter 50mm, angle of notch inclination 0^o, notch root radius 1.5mm and axial load 2500N, FEA steps and output are discuss as per following figures.

In order to take the advantage of geometrical symmetry, modeling geometry is done as shown in Figure 2. And

Figure 3 gives the loading condition on geometry. The material of the specimen is considered as Structural Steel having $S_{yt}=S_{yc}=2.5E+08Pa$, $S_{ut}=4.6\ E+08Pa$, Density=7850kg/m^3.

FEA Results give complete idea of the interference effect of stress concentration and strain concentration. In Figure 4 FEA gives Equivalent Stress. From Figure 4, we can understand the concept of the stress concentration at the notch root. Also stress interference is occurred at the notched length of double circumferential inclined notched. In Figure 5FEA gives Equivalent Strain which elaborates the concept of strain concentration at notch root and strain interference at notch length.

Stress intensity is maximum at notch root and interference of stress intensity is occurred at the notched length. Figure 6 and Figure 7 shows the Maximum Principal Stress (MPa) and Maximum Principal Strain and both indicate the interference of same clearly and Figure 8 gives the total maximum deformation (in mm).

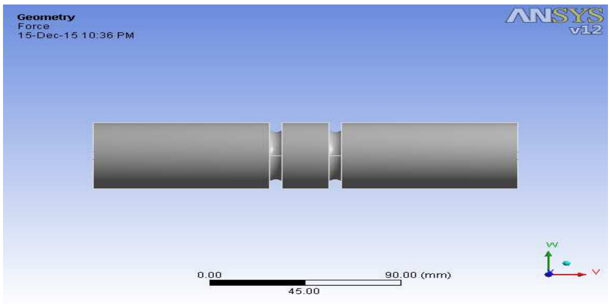

Figure 2: Model of Double U Notched Bar

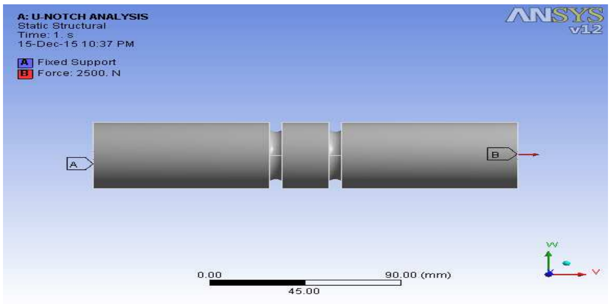

Figure 3: Load Applied

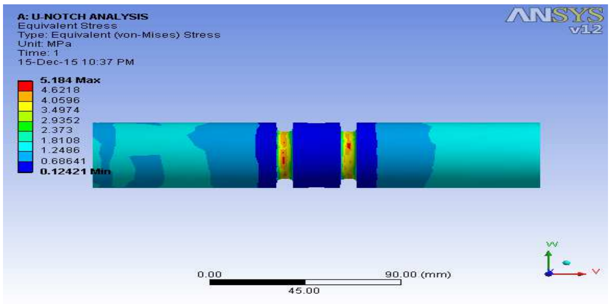

Figure 4: Equivalent Stress

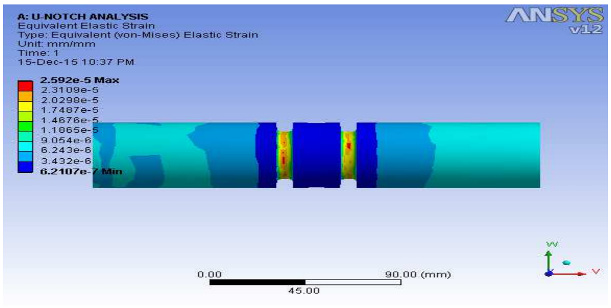

Figure 5: Equivalent Strain

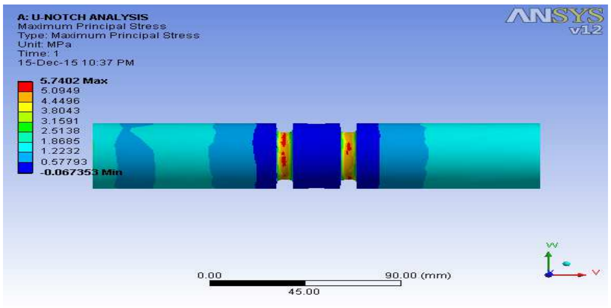

Figure 6: Maximum Principal Stress

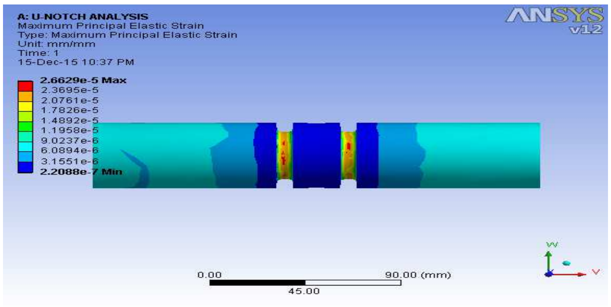

Figure 7: Maximum Principal Strain

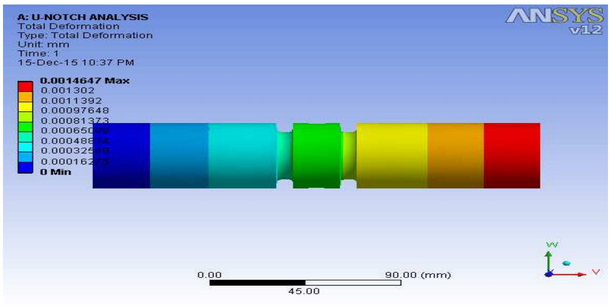

Figure 8: Total Deformations

Sample Results on V Shape Notch Bar

Effect on V Shaped No#tch at 2500N Axial Load

For notch depth 6mm, notched diameter 38mm and un-notched diameter 50mm, angle of notch inclination 0^o, notch root angle 105^0,notch width 5mm and axial load 2500N,FEA steps and output are discuss as per following figures.

In order to take the advantage of geometrical symmetry, modeling geometry is done as shown in Figure 9 and Figure 10 gives the loading condition on geometry. The material of the specimen is considered as Structural Steel having S_{yt}=S_{yc}=2.5E+08Pa, S_{ut} =4.6 E+08Pa, Density=7850kg/m^3.

FEA Results give complete idea of the interference effect of stress concentration and strain concentration. In Figure 11 FEA gives Equivalent Stress. From, Figure 11, we can understand the concept of the stress concentration at the notch root. In Figure 12 FEA gives Equivalent Strain which elaborates the concept of strain concentration at notch root and strain interference at notch length.

Stress intensity is maximum at notch root and interference of stress intensity is occurred at the notched length. Figure 13 and Figure 14 shows the Maximum Principal Stress (MPa) and Maximum Principal Strain and both indicate the interference of same clearly and Figure 15 gives the total maximum deformation (in mm).

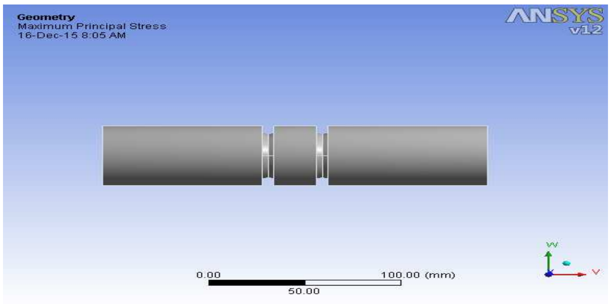

Figure 9: Model of Double V Notched Bar

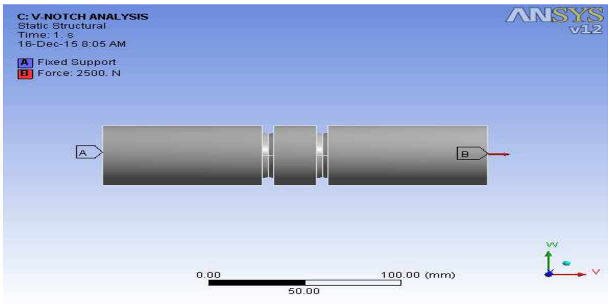

Figure 10: Load Applied

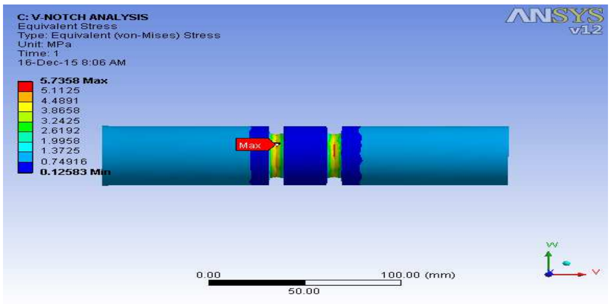

Figure 11: Equivalent Stress

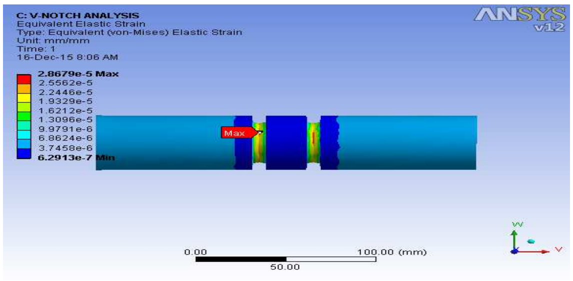

Figure 12: Equivalent Strain

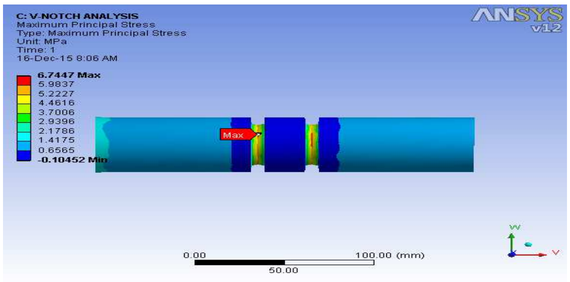

Figure 13: Maximum Principal Stress

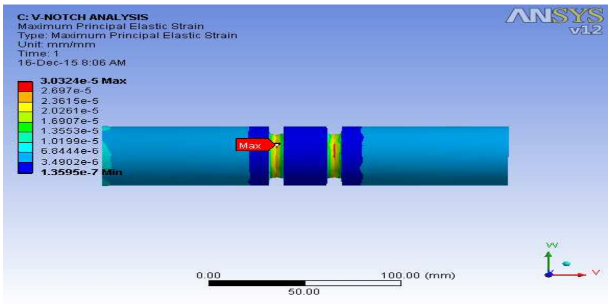

Figure 14: Maximum Principal Strain

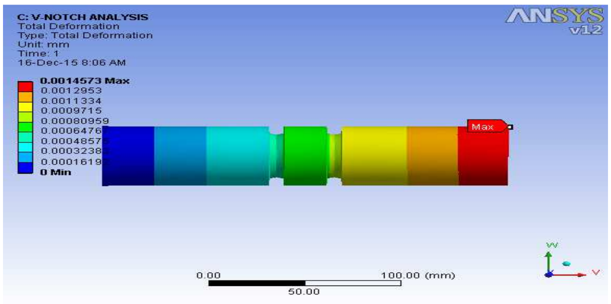

Figure 15: Total Deformations

From above sample FEA investigation of U and V shape notch bar studied the stress concentration at same load. Similarly different loads stress concentration results are comparing in the Table 1 and Figure 16 is as follows,

Table 1: Comparison of U and V Shape Notch Shaft by FEA Analysis

Force	U-FEA	V-FEA	Difference
(N)	Max Principal Stress(Mpa)	Max Principal Stress(Mpa)	in stresses (Mpa)
2500	5.7402	6.7447	1.005
5000	11.48	13.489	2.009

Table 1: Contd.,

7500	17.221	20.234	3.013
10000	22.961	26.979	4.018
12500	28.701	33.723	5.022
15000	34.441	40.468	6.027

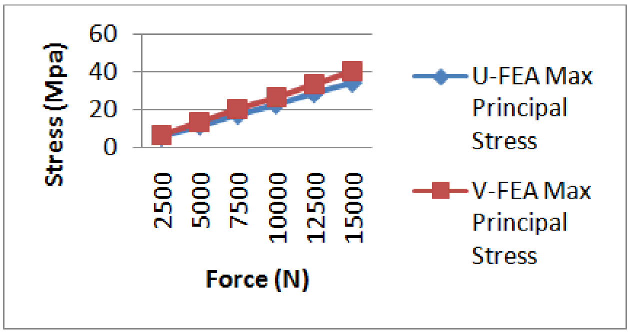

Figure 16: Comparison Stress Concentration of U and V Shape Notch Shaft by FEA Analysis

From above Table 1and Figure shows the result comparison of stress concentration values between U and V shape notch bar. Figure 16 shows the graph of stress concentration value is maximum in V shape notch shaft at same loadings condition. Hence proved the U shape double circumferential notch bar is working safe compare to V shape double circumferential notch bar at same loading cases.

CONCLUSIONS AND FUTURE ENHANCEMENT

From above the investigation we studied that the stress and strain concentration is observed in U shape and V shape double circumferential notch at various axial loads. In this investigation maximum stress concentration value is observed at V shape notch root section. Hence, we studied U shape double circumferential notch bar is working safely compare to V shape double circumferential notch bar at same loading cases.

In future experimental investigation of the same to validate the FEA results should be done.

REFERENCES

1. *Hitham M. Tlilan, Ali M. Jawarneh, Ahmad S. Al-Shyyab; "Strain-Concentration Factor of Cylindrical Bars with Double Circumferential U-Notches under Static Tension", Jordan Journal of Mechanical and Industrial Engineering, Volume 3, Number 2, June. 2009, ISSN 1995-6665, Pages 97 - 104.Hitham M. Tlilan; "Elastic Strain-Concentration Factor of Notched Bars under Combined Loading of Static Tension and Pure Bending", World Academy of Science, Engineering and Technology 64, 2012.*

2. *Hitham M. Tlilan, Ahmad S. Al-Shyyab, Tariq Darabseh, Majima Tamotsu; "Strain-Concentration Factor of Notched Cylindrical Austenitic Stainless Steel Bar with Double Slant Circumferential U-Notches Under Static Tension", Jordan Journal of Mechanical and Industrial Engineering, Volume 1, Number 2, Dec. 2007, ISSN 1995-6665, Pages 105 - 111.*

3. *Prof. Harshal Deore, Mr. Devendra Deore, Prof. Rajendra Chaudhari; "Analysis of Stress Concentration of Notched Bar", International Journal of Modern Trends in Engineering and Research, ISSN No.:2349-9745,date: 2-4 July,2015.page no.1967-1972.*

4. Prof. Patil R. D., Prof. Sancheti S. D., Mr. H.S. Deore; “Interference Effect of Different Notch Parameters on Elastic Stress & Strain Concentration of Notched Bar”, International Journal of Innovation and Automobile Engineering ISSN: 2249-2968 Issue-III, 2012 Pages 90-101.
5. Sandip Salmuthe, Abhijeet Kolhe, Kiran Dhage, Karishma Patil, Prof. Harshal S. Deore; “FEA Of Double Notched Bar”, International Journal of Modern Trends in Engineering and Research, e-ISSN No.:2349-9745, Date: 2-4 July, 2015, Pages. 1621-1626.
6. Lucjan sniezek, Jerzy Malachowski; “analysis of stress and strain concentrations in notched members made of alloys d16 and 1460”, Technical science Abbrev. Tech. Sc., Pap. And Rep., No 9, Y. 2006.Pages 95-109.
7. Nathan j. Mutter; “Stress concentration factors for v-notched plates under axisymmetric pressure”, Thesis submitted in the Burnett Honors college at the University of Central Florida Orlando, Florida Spring Term 2010.
8. H. M. Tlilan; " Effect of Poisson’s Ratio on the Elastic Strain Concentration Factor of Notched Bars under Static Tension and under Pure Bending", Jordan Journal of Mechanical and Industrial Engineering, Volume 4, Number 6, December 2010, ISSN 1995-6665, Pages 757 - 778.
9. G.R.Jones, M.A.Laughton and M.G.Say, “Electrical engineers reference book”, Point no.3.12.7 page no.3/38 and 3/39.